4.5. Storm Water Runoff Management

Management Measure for Storm Water Runoff:

Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas.

Reduce the average annual loadings of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For the purposes of this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

Management Measure Description

Any debris that is on the ground and light enough to be swept away by flowing rainwater or snowmelt can end up in lakes, reservoirs, ponds, rivers, streams, canals, bays, estuaries, or oceans. Sanding dust, paint chips, metal filings, and other such solids that might be carelessly or inadvertently allowed to drop to the ground while maintaining or repairing a boat can be swept up by the runoff of the next rainstorm. Oils, grease, solvents, paint drippings, and fuel spilled or dripped onto the ground can also be carried away in the runoff. Unless the runoff is controlled or treated in some manner, all of these pollutants will end up in the marina basin, where they will create unsightly surface films or float until they adhere to surfaces like boat hulls or docks. Some of these pollutants flow dissolved in runoff or attached to soil carried by the runoff. When they reach the marina basin, they sink with the soil to the bottom, are eaten by bottom-feeding fish or by filter-feeding shellfish, or settle onto the leaves of aquatic vegetation and clog their pores. Storm water that is treated in some way to remove these pollutants before they can reach the marina basin will not result in these problems.

The National Pollutant Discharge Elimination System (NPDES) was created to control pollutant discharges to the nation's waters, including those from storm water runoff. The 1987 amendments to the Clean Water Act mandated EPA to develop a tiered implementation strategy for the NPDES Storm Water Program. In response to the 1987 Amendments, EPA developed Phase I of the NPDES Storm Water Program in 1990. Phase I requires NPDES permits for storm water discharges from:

- "Medium" and "large" municipal separate storm sewer systems (MS4s) that serve or are located in incorporated places or counties with populations of 100,000 or more people; and

- Eleven categories of industrial activity, one of which is construction activity that disturbs five acres or greater of land.

The eleven categories of industrial activities for which storm water discharge permits are required are defined at 40 CFR 122.26(b)(14). A permit is required for Standard Industrial Classification (SIC) code 4493 (marinas) and SIC 3732 (boatyards and boat builders that repair, clean, and/or fuel boats). Note that the North American Industry Classification System (NAICS) is replacing the U.S. Standard Industrial Classification (SIC) system, and is scheduled to be completed by 2002 (Table 4-1). NAICS was developed jointly by the United States, Canada, and Mexico to provide new comparability in statistics about business activity across North America. NAICS numbers corresponding to the previous SIC numbers are provided in Table 4-1.

The second phase, known as Storm Water Phase II, was signed by EPA in October 1999 and published in the Federal Register on December 8, 1999. The Phase II Rule will bring municipal separate storm sewer systems serving fewer than 100,000 people, census districts within counties with population densities greater than 1,000 per square mile, and small construction sites of between one and five acres into the NPDES permitting program by March 2003. Construction sites where more than one acre is disturbed will need to obtain a permit and implement management practices (BMPs) to mnimize erosion and pollutant runoff. The rule exempts form regulation facilities that have industrial materials or activities that are not exposed to rain or snow. The Storm Water Rule and further information on Phases I and II of the Storm Water Program can be obtained from the EPA web site at http://www.epa.gov/owm/npdes.htm.

Removal of TSS at the 80-percent level is practicable, and the management practices mentioned here, or combinations of them, can achieve this degree of pollutant removal if they are designed properly and the site is suitable for their installation and use. The 80-percent level also provides a high degree of protection for surface waters. Used properly, source controls can also reduce final TSS concentrations in runoff very effectively. Table 4-2 reviews the pollutant removal efficiencies of many storm water control practices.

The 80 percent removal of TSS is applicable to hull and engine maintenance areas only, the runoff from which often contains higher levels of toxic pollutants than runoff from other parts of a marina property. Pollutants in runoff from the remaining marina property should be considered when designing an effective runoff pollution prevention system. If sufficient land area is not available onsite to install runoff systems, management practices that increase vegetative cover, reduce impervious services, and include infiltration devices are practical solutions.

The principal pollutants in runoff from marina parking areas and hull maintenance areas are suspended solids (paint chips, sanding dust, etc.) and organics (predominately oil and grease). Toxic metals (in antifoulant paints) from boat hull scraping and sanding tend to attach themselves to suspended soil particles, and are carried to the marina basin with the particles.

Designing and operating a hull maintenance work area with a focus on pollution prevention is an excellent way of preventing dangerous pollutants from reaching the marina basin. Particularly effective practices are designating a specified area that has an impervious surface (cement, for example) for hull maintenance work; doing all hull maintenance work under a roof to prevent the area from getting wet; and channeling and draining runoff from other areas of the marina property away from hull maintenance areas so it won't pick up the pollutants associated with hull maintenance. Devices with controls that collect pollutants as they are produced, such as vacuum-based (or dustless)

Table 4-1. Conversion of SIC to NAICS.

SIC	NAICS	
3732 Boat Building and Repairing		
Boat Repair	81149	Other Personal and Household Goods Repair and Maintenance (part)
Boat Building	336612	Boat Building
4493 Marinas	71393	Marinas

Table 4-2. Storm Water Management Practice Summary Information.

Practice - Characteristics	Pollutants Controlled	Removal Efficiencies (%)	Use with Other Practices	Cost	Retrofit Suitability	References	Pretreatment of Runoff Recommended
Sand Filter	TSS TP TN Fecal Col Metals	60-90 0-80 20-40 40 40-80	Yes	\$1 - 11 per ft^3 of runoff	Medium	City of Austin, 1990; Schueler et al., 1991; Tull 1990	Yes
Infiltration Basin/Trench	TSS TP TN BOD Bacteria Metals	50-99 50-100 50-100 70-90 75-98 50-100	Yes	Of capital costs: Basins = 3-13 Trenches = 5-15	Medium	Schueler, 1987, 1991	Yes
Porous Pavement	TSS TP TN COD Pb Zn	60-90 60-90 60-90 60-90 60-90 60-90	No	Incremental cost: \$40,051-78,288 per acre	Low	Schueler, 1987; SWRPC, 1991; Cahill Associates, 1991	
Vegetated Filter Strip	TSS TP TN COD Metals	40-90 30-80 20-60 0-80 20-80	Combine with practices for MM	Seed: \$200-1000 per acre; Seed & mulch: \$800-3500 per acre; Sod: \$4500-48,000 per acre	High	Schueler et al., 1992	No
Grassed Swale	TSS TP TN Pb Zn Cu Cd	20-40 20-40 10-30 10-20 10-20 50-60 50	Combine with practices for MM	Seed: \$4.50-8.50 per linear ft; Sod: \$8-50 per linear ft	High	SWRPC, 1991; Schueler, 1987; Schueler et al., 1991; Horner, 1988; Wanielistra and Yousef, 1986	No
Swirl Concentrator	TSS BOD		Yes		High	WPCF, 1989; Pisano, 1989; USEPA, 1982	No
Catch Basins	TSS COD	60-97 10-56	Yes	\$1100-3000	High	WPCF, 1989; Richards et al., 1981; SWRPC, 1991	No

Table 4-2. (cont.)

Practice - Characteristics	Pollutants Controlled	Removal Efficiencies (%)	Use with Other Practices	Cost	Retrofit Suitability	References	Pretreatment of Runoff Recommended
Catch Basin with Sand Filter	TSS TN COD Pb Zn	70-90 30-40 40-70 70-90 50-80	High	$10,000 per drainage acre		Shaver, 1991	No
Swirl Concentrator	TSS BOD		Yes		High	WPCF, 1989; Pisano, 1989; USEPA, 1982	No
Catch Basins	TSS COD	60-97 10-56	Yes	$1100-3000	High	WPCF, 1989; Richards et al., 1981; SWRPC, 1991	No
Catch Basin with Sand Filter	TSS TN COD Pb Zn	70-90 30-40 40-70 70-90 50-80	High	$10,000 per drainage acre		Shaver, 1991	No
Adsorbents in Drain Inlets	Oil	High	Yes	$85-93 for 10 pillows		Silverman and Stenstrom, 1989; Industrial Products and Lab Safety, 1991	No
Holding Tank	All	100 for first flush	Yes			WPCF, 1989	No
Boat Maintenance Area Design	All	Minimizes area of pollutant dispersal	Yes	Low	High	IEP, 1992	No
Oil-grit Separators	TSS	10-25	No		High	Romano, 1990; Schueler, 1987; WPCF, 1989	No

sanders, are also effective for preventing pollutants from entering runoff.

Pollutants can also be trapped, collected, or filtered after they are on the ground but before it rains. This can be accomplished by using street sweepers and vacuums that collect debris from the ground, placing tarps under boats while they are being sanded or painted, and planting grass buffers around hull maintenance areas, parking lots, sidewalks, and other impervious surfaces where pollutants tend to accumulate. Grass buffers effectively filter runoff water before it reaches surface waters, and they are attractive landscape elements.

Covering areas that are not used for boat maintenance with a porous surface allows rainwater to filter into the ground and reduces the amount of runoff created on the marina property. Crushed gravel or concrete and low grassy areas interspersed around and within otherwise impervious areas (parking lots, for example) are surfaces that allow rainwater to infiltrate into the

ground. Directing storm water to a grassed area instead of to drains, pipes, or cement channels is an effective way to prevent the pollutants in runoff from reaching the marina basin, whether the runoff originates from parking lots, hull maintenance areas, rooftops, or any other impervious surface.

Some marinas may need to pretreat storm water runoff before it is discharged to a local sewer system. Pretreating wastewater from hull cleaning (pressure washing) might also be needed. The state or local environmental agency should be contacted to determine any specific legal requirements for treatment before discharge.

The goal of 80 percent reduction in the load of total suspended solids (TSS) in storm water runoff recommended in this management measure is achieved by eliminating (by pollution prevention or source reduction) 80 percent of the total annual load of suspended materials produced in an average year of work. Most marinas use some management practices, and are already collecting some or all of this 80 percent. Note that 80 percent of the TSS load cannot usually be eliminated during each storm, since the efficiency of any means chosen to remove pollutants from storm water fluctuates above and below 80 percent for individual storms. The goal of the management measure is to control an average of 80 percent of the amount of TSS produced at a marina during any given year. Since no two marinas are the same, the storm water control management practices used to achieve this goal have to be chosen site-specifically for each marina.

The annual TSS load baseline can be calculated as follows:

- Assume that marina operations are being conducted as usual, except that *no* management practices are used to collect pollutants from hull maintenance areas. All of the sanding dust, paint chips, etc. produced fall to the ground.

- Given this scenario, add together the total amount of *solid* pollutants, such as paint chips and sanding dust, that would be swept away in runoff during storms that occur over a 1-year period and that are less than or equal to the 2-year/24-hour storm for the area. Solids carried away in snowmelt runoff should also be included.

- Multiply this quantity by 80 percent (0.80) to obtain the target minimum quantity of solid pollutants to be removed from storm water runoff and prevented from reaching the marina basin or storm drain.

This calculation can be complicated, primarily because of the difficulty in measuring the quantity of pollutants produced at a marina. The state or local environmental agency can be contacted for additional storm water guidance and for information pertaining to storm water regulation.

Best Management Practices

Pollution Prevention Practices

- *Perform as much boat repair and maintenance work as possible inside work buildings.*

Sandblasting is best performed in a place where the debris produced is prevented from drifting to surrounding areas and being swept away in storm water runoff. One of the simplest and most effective ways to prevent pollutants from boat repairs from entering storm water runoff is to perform as much work as possible under roofs. Performing maintenance work in a fully enclosed building protects the work area from wind and contains the dust and debris produced during the work, so it is much easier to clean up afterward.

- *Where an inside work space is not available, perform abrasive blasting and sanding within spray booths or tarp enclosures.*

The inside of a building provides the most protected space, but if a large enough interior space is not available, a suitably sized area can be protected with tarps. Tarps will help prevent residue from drifting to nonwork areas of the marina and into surface waters. Scheduling work on calm days will help ensure that wind won't

carry debris and pollutants to other areas of the marina property and the marina basin.

- *Where buildings or enclosed areas are not available, provide clearly designated land areas for boat repair and maintenance.*

If a facility is large enough, one section of the yard, well away from the shore, can be designated for boat repairs and maintenance (Figure 4.8). Mark the area well with signs, post a list of boat owner responsibilities, indicate the rules for use of the work area, and do not permit work outside of the designated areas. This should help the marina property stay relatively clean. Where possible, an inland area, away from surface waters, can be used for boat repair work.

- *Design hull maintenance areas to minimize contaminated runoff.*

Hull maintenance areas can be designed so that all activities that produce a large amount of polluting debris can be accomplished over a dry, impervious surface like a cement pad. Such a surface makes it easy to collect and properly dispose of debris, residues, solvents, and spills before they enter storm water runoff.

Figure 4.8. Conanicut Marine Service (Rhode Island) found that purchasing land almost a mile from the shore and using a hydraulic boat trailer was significantly less expensive than purchasing waterfront property, and doing so allowed expansion of its service work to an inland boatyard. No coastal permits were needed for the inland yard, and the risk of water pollution from runoff from the yard was significantly reduced (EPA, 1996: *Clean Marinas—Clear Value*).

- *Use vacuum sanders both to remove paint from hulls and to collect paint dust.*

Vacuum sanders have proven very effective at capturing paint dust during boat hull and bottom sanding. Immediate capture prevents paint dust from entering the marina basin, makes cleaning up the work area easier, and increases the speed at which a boat bottom can be completely sanded.

Such sanders capture over 98 percent of the dust generated. Workers do not have to wear full suits with respirators. They use fewer disk pads and have less clean-up in surrounding areas. Vacuum-based sanders are increasingly being used in boatyards and marinas, and might be available for renting by boat owners who want to sand their own hulls. Many marinas have converted exclusively to dustless sanders and require that they be used by customers and outside contractors. In addition to preventing pollution, using vacuum sanders can dramatically increase the efficiency of sanding operations.

The results of a BMP demonstration project at five Rhode Island marinas showed that several techniques can make the use of vacuum sanders more effective. First, the availability of the machinery needs to be publicized with flyers or signs in hull maintenance areas. Second, staff should be well trained and ready to inform customers that a professional vacuum sander is available for use, and how to use it properly. Users need to be given operating instructions and clearly understand them before using the machine. Finally, use of the sanders should be monitored (how often they are used and the percentage of hull maintenance work done with vacuum sanders) and the information provided to the regulatory agency, or used for making decisions about future use of the sanders at the marina.

- *Restrict the types and/or amount of do-it-yourself work done at the marina.*

Largely for environmental liability reasons, an increasing number of marinas owners are

restricting do-it-yourself boat repair work of the "dirty" kind, such as exterior sanding and painting. A small but increasing percent of marinas are prohibiting such repairs on site unless done by a professional who is trained in, understands, and follows state-approved environmental management practices.

Source Reduction Practices

- *Clean hull maintenance areas immediately after any maintenance to remove debris, and dispose of collected material properly.*

Cleaning hull maintenance areas immediately after maintenance or repair work is done removes trash, visible paint chips, and other debris before they can be blown or washed into the marina basin. Spent sandblasting grit, boat repair debris, and solid waste should be stored under cover and in a manner that minimizes contact with process or storm water. Vacuuming or sweeping is an excellent method of collecting these wastes, especially over paved surfaces. Hosing a maintenance area for cleanup can result in the same pollution that storm water would cause.

- *Capture and filter pollutants out of runoff water with permeable tarps, screens, and filter cloths.*

Tarpaulins can be placed on the ground, before a boat is placed in a cradle or stand for sanding and painting. The common plastic tarpaulins collect paint chips, sanding dust, and paint drippings, which then can be collected and disposed of into dumpsters with other solid trash, as permitted by local or state ordinances. Impermeable plastic tarps, however, have their drawbacks. Wind easily blows dust and chips off the tarps, and rainwater washes debris from the tarps. Semipermeable filter cloths can be more effective than solid cloth or plastic tarps for collecting debris where wind is a problem, where tarps are not always cleaned each day after work is completed, or where work is continued during light rains. The filter cloths hold onto debris better and allow water to pass through while retaining debris for later disposal.

- *Sweep and/or vacuum around hull maintenance areas, roads, and driveways frequently.*

Frequent vacuuming impervious areas can effectively prevent pollutants from reaching the marina basin and non-maintenance areas of the marina property. Scheduling vacuuming (e.g., once a day or every other day during the boating season) and adhering to the schedule helps make this a particularly effective management practice. The practice is most effective in hull maintenance areas if the surface under any boat being worked on is swept at the end of each work day.

- *Sweep parking lots regularly.*

Cars, trucks, commercial vehicles, and foot traffic carry a lot of sand, grit, and dirt to parking lots. Gum wrappers, paper and styrofoam cups, cigarette butts, and cellophane wrappings tend to end up on parking lot pavement as well. Storm water carries these pollutants to the marina basin or to drain inlets, catch basins, and oil/grit separators. Regular parking lot sweeping will help reduce the amount of sand, grit, and trash that reached the marina basin and storm water controls. Since catch basins and oil/grit separators require periodic cleaning for efficient operation, sweeping the parking lot will extend the time between cleanings.

- *Plant grass between impervious areas and the marina basin.*

Grass retains and filters pollutants from runoff. A well-maintained lawn located between impervious surfaces (e.g., parking lots) and the marina basin and to which runoff from the impervious surface is directed increases rainwater infiltration and creates an attractive marina environment (Figure 4.9).

The technical term for a channel or ditch planted with grass and used for storm water treatment is "grassed swale." Grassed swales are low-gradient channels that can be used in place of buried storm drain pipes (Figure 4.10). To effectively remove pollutants, grassed swales need to have only a slight slope and should be long enough to allow

Figure 4.9. Stormwater runoff is controlled at Deep River Marina (Connecticut) by 50-foot-wide grass buffers and a parking lot that is covered with crushed rock and has sediment traps in the storm drains. Picnic tables and flowers in the lawn areas make the marina visually attractive and useful to families. Summerfield Boat Works (Florida) added an unpaved parking lot across the street from the main marina property and basin and landscaped its perimeter to blend in with the neighborhood. Harbour Towne Marina (Florida) reduced runoff contamination by planting a grass buffer around the perimeter of the facility. The facility's parking is largely paved and drains to the buffer strip, and the grass adds a cooling and visually pleasing element to the marina property (EPA, 1996: *Clean Marinas—Clear Value*).

all of the pollutants in storm water to be filtered out. Because storm water is directed to them and storms are occasionally very strong, erosion-resistant vegetation such as deep-rooted grasses works best. The vegetation filters out pollutants and absorbs nutrients from the storm water, and runoff infiltrates into the ground as it is slowed by the grass in the swale. Grassed swales are best used in conjunction with other practices listed under this management measure.

- *Construct new or restore former wetlands where feasible and practical.*

If space and economy permit, consider restoring wetland vegetation that might have formerly existed at the edge of the marina basin or altering a portion of the basin perimeter to support wetland vegetation. Wetlands are extremely efficient at removing pollutants from water.

- *Use porous pavement where feasible.*

Porous pavement has a coarse, permeable top layer covering an additional layer of gravel (Figure 4.11). Runoff infiltrates through the porous layer and into the ground. As storm water passes through the pavement, the gravel, and perhaps through a perforated underground pipe system and then into the underlying soil, pollutants are naturally filtered out. Porous pavement helps recharge ground water and provides excellent pollutant removal (up to 80 percent of sediment, trace metals, and organic matter).

- *Install oil/grit separators to capture petroleum spills and coarse sediment.*

Oil/grit separators are useful where petroleum is spilled or could be spilled (Figure 4.12). Oil/grit separators can be used to treat water from small areas where other measures are infeasible. They are particularly applicable where the work performed contributes large loads of grease, oil, mud, or sand to runoff. The chambers in oil/grit separators should be cleaned out periodically or their efficiency decreases. Inspection and maintenance twice a year is usually sufficient. With proper maintenance, oil/grit separators can last 50 years.

- *Use catch basins where storm water flows to the marina basin in large pulses.*

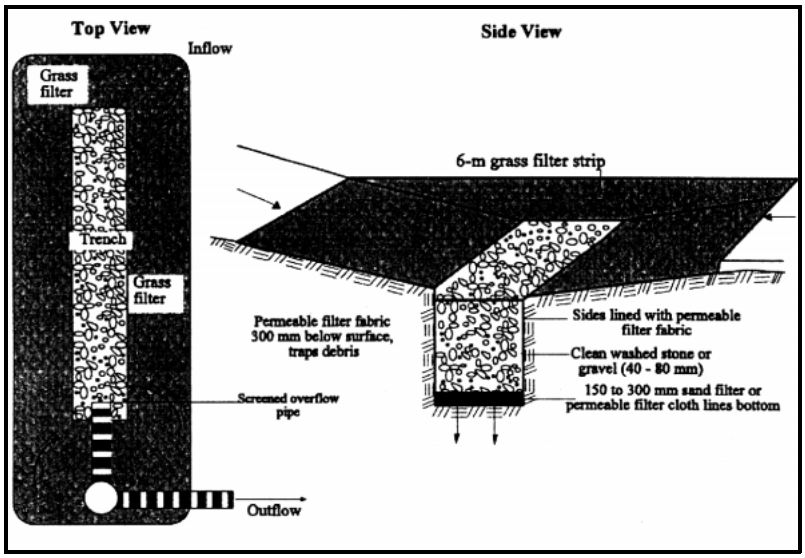

Figure 4.10. Grassed filter strip surrounding an infiltration trench (adapted from Schueler, 1987)..

Catch basins with flow restrictions are used to prevent large pulses of storm water from entering the marina basin at one time. Particulates and soil settle to the bottom of a catch basin, in which the bottom of the basin is typically 2 to 4 feet below the outlet pipe (the pipe through which the trapped water is allowed to escape). The traps in a catch basin require periodic cleaning and maintenance, but if properly maintained, a catch basin should have a life span similar to that of oil/grit separators (50 years).

Catch basins can have a separate chamber filled with sand. With this design, runoff first enters an open chamber where coarse particles that could clog the sand filter out. The runoff then flows into a second chamber where other pollutants are filtered out by infiltrating through the sand. Catch basins with sand filters are effective in highly impervious areas, where other practices have limited usefulness. They need to be inspected at least annually, and the top layer of sand should be removed periodically and replaced with fresh, clean sand.

Harbour Towne Marina (Florida) modified its yard storm drains to hold an ordinary air conditioner filter, which effectively stops suspended solids from passing through (EPA, 1996: *Clean Marinas—Clear Value*).

- *Add filters to storm drains that are located near work areas.*

Some storm drain designs will permit a filter to be inserted in them to screen solid materials out of runoff. If oil is typically contained in runoff, an oil absorption pad can be inserted into the water pool or trap beneath the filter as well.

- *Place absorbents in drain inlets.*

Oil and grease are not ordinarily captured by catch basins. An absorbent material placed in a drain where it will intercept storm water can remove much of the oil and grease contained in runoff. Absorbent material products can remove 10 to 25 times their weight in oil.

- *Use chemical and filtration treatment systems only where necessary.*

Figure 4.11. Lockwood Boat Works (New Jersey) regraded and surfaced its combined parking and boat maintenance yard with 6 inches of crushed concrete to successfully control runoff. Using recycled concrete crushed into stone-sized pieces, the cost was $18,000 per acre installed, whereas crushed rock would have cost $27,000 per acre and asphalt paving would have cost $54,000 per acre (EPA, 1996: *Clean Marinas—Clear Value*).

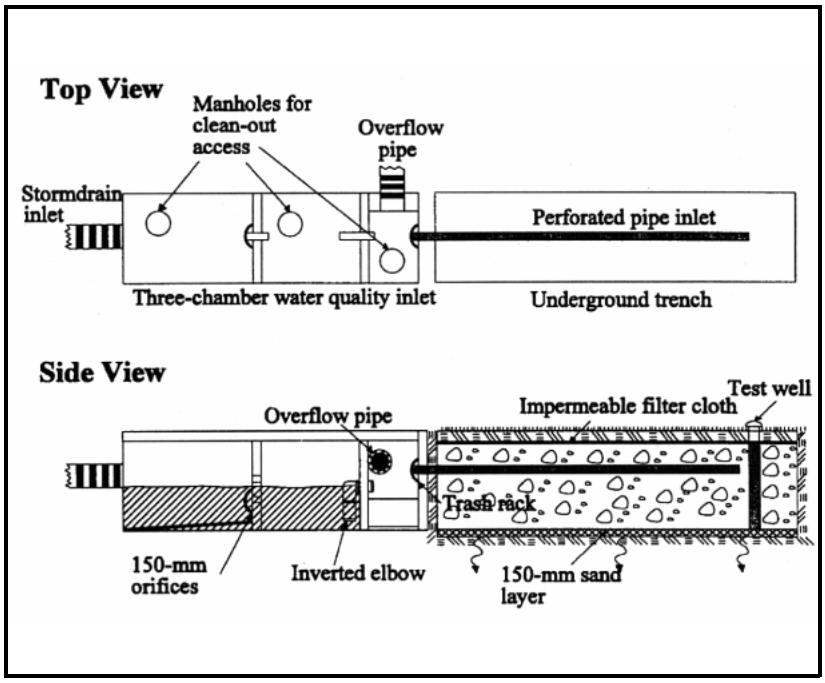

Figure 4.12. Underground trench with oil/grit chamber (adapted from Schueler, 1987).

Wastewater can be chemically treated by the addition of certain chemicals that cause small solid particles to adhere together to form larger particles, which are then filtered from the water. This type of treatment system can remove more than 90 percent of the suspended solids and 80 percent of most toxic metals associated with hull pressure-washing wastewater. The degree of treatment is determined by how much of the chemical is added and the porosity of the filter used, and can be altered to meet municipal standards. Since the chemicals used for this type of treatment require disposal themselves, this method of pollutant removal is suggested to be used only where other methods prove ineffective.

BMP Summary Table 5 summarizes the BMPs for Storm Water Runoff control mentioned in this guidance.

BMP Summary Table 5. STORM WATER RUNOFF MANAGEMENT

MANAGEMENT MEASURE - Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas. Reduce the average annual loadings of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For the purposes of this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

ENVIRONMENTAL CONCERNS:

Sanding dust, paint chips, metal filings, and other such solids that drop on the ground during boat repair and maintenance can all be swept into the water by the next rainstorm's runoff. Oils, grease, solvents, paint drippings, and fuel spilled or dripped onto the ground will also be carried away in the runoff. Unless runoff is treated in some manner, all of these pollutants will end up in the marina basin, where they will create unsightly surface films or float until they adhere to a surface, like a boat hull. Some of these pollutants can sink with the the bottom soil, where they can be eaten by bottom-feeding fish or filter-feeding shellfish, or settle onto the leaves of aquatic vegetation and clog their pores.

Best Management Practice Examples & Type	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
POLLUTION PREVENTION PRACTICES						
Perform as much boat repair and maintenance work as possible inside work buildings	Boat maintenance area – universally recommended	MODERATE to HIGH; protects the work area from wind and rain; contains dust and debris for easier cleanup	MODERATE to HIGH; simple and effective way to prevent pollutants from entering storm water runoff	LOW if building exists to EXPENSIVE for new building	MODERATE	Temporary plastic buildings can be relatively inexpensive; sheet plastic cover will need replacing every few years
Where an inside work space is not available, perform abrasive blasting and sanding within spray booths or tarp enclosures	Boat maintenance area – universally recommended	MODERATE to HIGH; protects the work area from wind and rain; contains debris for easier cleanup	MODERATE to HIGH	MODERATE	MODERATE	Schedule work on calm days to help ensure that debris and pollutants are not carried to other areas of the marina property and the marina basin
Where buildings or enclosed areas are not available, provide clearly designated land areas for boat repair and maintenance	Hull maintenance in designated upland areas –generally recommended	MODERATE; keeping all work in one area helps control pollutants	HIGH; keeping the work away from the water is an effective way to protect water quality	LOW to MODERATE	LOW to MODERATE	Area should be well marked with signs; post a list of boat owner responsibilities and work area rules; perform work on calm days to prevent drift.

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT						
Best Management Practice Examples & Type	**Marina Location & Usage**	**Benefits to Marina**	**Projected Environmental Benefits**	**Initial Cost Estimate**	**Annual Operation & Maintenance Cost Estimate**	**Notes**
Design hull maintenance areas to minimize contaminated runoff	Boat maintenance area – universally recommended	MODERATE to HIGH; debris collection and cleanup is easier when appropriate controls are in place	HIGH; decreases possibility that maintenance debris will enter waterbody with runoff	MODERATE to HIGH	MODERATE	Construct hull maintenance areas with an impervious surface like cement; mark the boundaries of maintenance areas with clear visible signs.
Use vacuum sanders both to remove paint from hulls and to collect paint dust	Hull maintenance areas –universally recommended	HIGH; perhaps the most efficient and effective practice; easy to use; saves cost of cleanup, improves quality and speed of hull work	HIGH; 98% effective at keeping sanding dust out of environment	LOW to MODERATE per unit	LOW per unit	Rental fee income can defray capital cost; can require that all customers and outside contractors use them.
Restrict the types and/or amount of do-it-yourself work done at the marina	Marina wide policy – generally recommended	MODERATE to HIGH; controls the number and types of pollutants and pollution sources	MODERATE; reduces the amount of work performed by a persons unfamiliar with environmental management practices	LOW	None	At first may be unpopular with customers used to do-it-yourself work; encourages use of professionally trained work
SOURCE REDUCTION PRACTICES						
Clean hull maintenance areas immediately after any maintenance to remove debris, and dispose of collected material properly	Hull maintenance areas – universally recommended	MODERATE; daily cleaning of work areas reduces accidents, improves work quality, and increases customer satisfaction	MODERATE; reduces amount of maintenance debris and litter blowing around marina and into the water; sweeping keeps litter and sand out of storm drains	LOW	MODERATE	Vacuuming is the best method of collecting wastes; sweeping works but not as well; minimize use of hose water for cleaning ground since runoff can enter the water the same as rain.

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples & Type	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Capture and filter pollutants out of runoff water with permeable tarps, screens, and filter cloths	Upland and indoor maintenance areas – generally recommended	MODERATE; debris is more easily collected and disposed into dumpsters with other solid trash, as permitted by local or state ordinances; inexpensive, reusable materials	MODERATE to HIGH for semipermeable filter cloths; LOW for impermeable plastic tarps	LOW	LOW	Tarps need daily cleaning and are subject to wind blowing and rain runoff; semipermeable filter cloth tarps are better.
Sweep and/or vacuum around hull maintenance areas, roads, and driveways frequently	Marina upland areas – universally recommended	HIGH to MODERATE; sweeping reduces the need to clean the basin; keeps marina attractive	MODERATE to HIGH; regular sweeping keeps sand, grit, and debris out of surface waters	LOW; HIGH if mobile sweeper purchased	MODERATE	Most of the cost is in labor; clean grounds encourage boaters to keep the marina and waters clean.
Sweep parking lots regularly	Marina parking lots and roads – universally recommended	HIGH to MODERATE; sweeping the parking lot will extend the time between cleanings of catch basins and oil/grit separators; keeps marina attractive	MODERATE to HIGH; regular sweeping keeps litter and sand out of storm drains and the water	LOW; HIGH if mobile sweeper purchased	MODERATE	Most of the cost is in labor, but the benefits from having a clean marina are high; clean grounds encourage boaters to help keep the marina and waters clean.
Plant grass between impervious areas and the marina basin	Between marina work and parking areas and shoreline – generally recommended	HIGH; creates an attractive buffer, which add good appearance; if wide enough can serve as recreation area for boaters	HIGH; lawn grass is a very effective buffer; retains and filters pollutants from runoff; absorbs nutrients from storm water; stabilizes the shore	MODERATE	MODERATE	A shallow ditch planted with grass and used for storm water treatment is a "grassed swale," serves as a low-gradient runoff channel and settlement trap.
Construct new or restore former wetlands where feasible and practical	Shore and water edge – recommended where space allows	MODERATE to HIGH; wetlands are attractive shoreline habitat; attract customers	MODERATE to HIGH; wetlands are extremely efficient at removing pollutants from the water; act as natural buffers; reduce erosion	HIGH to EXPENSIVE	HIGH to LOW	Not suitable where amount of water and land is limited; plantings can be hard to establish; but once thriving, can last for decades with little or no maintenance.

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples & Type	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use porous pavement where feasible	Marina parking lots and maintenance areas – generally recommended	HIGH to MODERATE; porous pavement can be cheaper than asphalt paving; reduced need for other elaborate/costly runoff control measures	HIGH; recharges ground water and provides excellent pollutant filtration through the ground	HIGH to EXPENSIVE	MODERATE to LOW	Recycled crushed concrete is less expensive than crushed stone, much cheaper than asphalt; not recommended near drinking water aquifers or wells.
Install oil/grit separators to capture petroleum spills and coarse sediment	Boat maintenance areas – generally recommended	MODERATE to HIGH; oil/grit separators should last 50 years with proper maintenance; minimal labor cost once installed	MODERATE to HIGH; efficient practice where the work performed contributes large loads of grease, oil, mud, sand, or trash to runoff	MODERATE per unit	LOW	Must be cleaned regularly; work efficiently if inspected and maintained at least twice a year; can be used to treat water from small areas where other measures are not feasible or cost-effective.
Use catch basins where storm water flows to the marina basin in large pulses	Marina storm drains – recommended	MODERATE to HIGH; with proper maintenance, catch basins should last 50 years	HIGH; catch basins with sand filters are effective in highly impervious areas, where other practices have limited usefulness	HIGH	LOW	Traps of catch basins require periodic cleaning and maintenance.
Add filters to storm drains that are located near work areas	Marina storm drains in work areas – generally recommended	MODERATE to HIGH; very low-cost; easy to get and replace; effectively filter out most large materials from runoff; simple and reliable	MODERATE to HIGH; screen larger solid materials out of water; not as effective for very small particles	LOW	LOW	Ordinary air conditioner filters can be used; require periodic maintenance; filters last many months; need to be held in place just below the drain cover.

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples & Type	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Place absorbents in drain inlets	Marina storm drains and catch basins – generally recommended	MODERATE; oil pads and pillows absorb most petroleum products effectively; low cost and readily available; easy inspection and replacement	HIGH; remove much of the oil and grease from runoff; can remove 10 to 25 times their weight in oil from water	LOW	LOW	Absorbent materials need to be inspected regularly and changed periodically; tie in place so that they do not enter pipes or clog systems; best used where water collects, such as in traps.
Use chemical and filtration treatment systems only where necessary	Boatyard work and hull cleaning areas – recommended	LOW; very effective but very expensive practice	HIGH; these systems can remove in excess of 90% of suspended solids and 80% of most toxic metals from hull pressure-washing wastewater	EXPENSIVE to HIGH	EXPENSIVE to HIGH	Require extensive use of chemicals; increased spill and health/safety hazard risk; unless legally required, considered unnecessary because of low quantities of toxics present in most marina runoff; degree of treatment can be altered to meet municipal standards.